Chapter 1: Introduction - molecular microbial ecology of Antarctic aquatic ecosystems

1.1 Why study Antarctic microbial ecosystems?

The Antarctica is a "cold desert" defined by constant low temperatures, little precipitation and long polar light cycles where only specially adapted organisms can survive. Life is concentrated on the few ice-free coastal oases where liquid water is present in hundreds of lakes and ponds. These include the Vestfold Hills, Bunger Hills, Larsemann Hills, Syowa Bay and McMurdo Dry Valleys in East Antarctica, the West Antarctic Peninsula and the sub-antarctic islands. Lake biota is dominated by microbial life where metazoans are rare or absent. Antarctic lakes span a wide range of physical and chemical properties from freshwater to hypersaline, ice-covered to permanently melted and stratified or mixed. Most lakes are largely isolated due to long periods of ice-cover and only receive intermittent external inputs from precipitation, glacial melt and in some cases marine incursion or animals. Permanently ice-covered lakes and the bottom waters of meromictic (permanently stratified) lakes are truly closed systems with some lakes having been isolated for thousands to millions of years. Eg. Lakes in the Dry Valleys, subglacial lakes. The relative isolation and extreme conditions make Antarctic lakes potential reservoirs of novel taxa or refuges for ancient life. There is some evidence that endemism is high in Antarctic microbiota.

Microbial communities in Antarctic lakes have reduced diversity and richness with shortened food webs. As a result, microbial processes are closely linked to lake geochemistry. As the lakes span a continuum of different environmental parameters, they present themselves as "natural laboratories" where comparisons can be made between lakes that vary in a property of interest. For example, lakes of different trophic statuses or salinities can be compared to determine adaptations to those environmental constraints. This makes Antarctic lakes ideal model ecosystems where it is possible to define the microbial community and infer the role members play within the system. Meromictic lakes similarly provide a unique opportunity to compare between the discrete zones within a single lake. This study focuses on two such meromictic lakes, Organic Lake and Ace Lake.

1.2 The Vestfold Hills, East Antarctica

-Location of the Vestfold Hills -Describe the formation of the Vestfold Hills -Number of lakes -Age -nutrient status -Its an important study site because.... -key biota in the Vestfold Hills.

1.2.1 Limnology of Organic Lake

-hypersaline,meromictic, cold, high DMS, high external inputs -early studies -microbiota known

1.2.2 Limnology of Ace Lake

-marine salinity, meromictic, interesting chemistrym, methanogenesis, sulfur cycle -isolates

1.3 Insights From Molecular-based Studies of Antarctic Aquatic Terrestrial Systems

-Most study sites have used 16S or 18S rRNA gene cloning, DGGE or FISH. -Have studied various lakes -Have found that for some systems there is no ifference between littoral vs limnetic zones. -Can associate eutrophia with key taxa. -Can complete the Nutrient cycle in blood falls. ##1.3.1 Key biota in Lakes ##1.3.3 viruses

Limitations of previous studies

Metagenomics and Metaproteomic approaches

Objectives

Overall, this study aimed to use metagenomic and metaproteomic approaches to gain an integrative understanding of the Ace and Organic Lake ecosystems. Using this methodology, not only can the taxonomic composition of the lakes be determined but also the functional potential of the microbial population and insight into the active members of the community. The objectives of the research were:

1) To determine the microbial and viral composition of the lake communities.
2) To determine the functional potential of the lake biota.
3) To reconstruct as much genomic information as possible of dominant taxa and to infer their physiology and ecological role.
4) To integrate environmental and biological data and model the lake microbial interactions and geochemical processes.